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ABSTRACT

A poorly designed data processing system in a school district testing office may cause a delay in the creation of test results, produce inaccurate results, or utilize more resources than are necessary. Therefore, the authors present a model of a data processing system as a basis for comparing systems in terms of the basic functions they must perform and the constraints under which they might operate. Optical scanning, editing, scoring, and creating reports and output files are the four functions which comprise the model, and the operation and interaction of each is outlined. The external constraints which are found in data processing systems are the resources available for use by the system, and the demands that are placed on the resources. These demands involve: (1) generating specified reports and tape files for later use; (2) insuring a specified degree of accuracy in the data; and (3) completing reports by a specified date. Creating a balance between system resources and demands is discussed. In addition, flow charts for the overall system and each of its functions are appended. (Author/JAC)

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DATA PROCESSING SYSTEMS FOR SCHOOL DISTRICT TESTING OFFICES

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DATA PROCESSING SYSTEMS FOR SCHOOL DISTRICT TESTING OFFICES

The data processing (dp) system which functions in a school district testing office is vital to the timely creation of accurate test results. A poorly designed dp system may (1) cause a delay in the creation of these results, (2) produce inaccurate results, and (3) utilize more resources than are necessary. The resulting costs, both monetary and other, are numerous and pervasive. Yet, there appears to be little systematic written guidance on how a dp system for test processing might best be designed or on potential hazards that might be avoided. This paper is an attempt to provide a model of a dp system as a basis for comparing different systems in terms of (1) the basic functions they must perform, and (2) the constraints under which they might operate. The strengths and weaknesses within each system will be discussed.

The Model: An Overview

A dp system for processing test results must perform four functions. These are:

- optical scanning (the transfer by optical scanning equipment of the marked answer sheet information to a computer-readable medium such as tape),
- editing (the detection and correction of: wrong or missing information; damaged answer sheets; improperly positioned answer sheets, etc.),
- scoring (the right-wrong scoring of each test item, computation of raw scores for each test and subtest, and the determination of derived scores such as grade equivalent or percentile scores), and
- creation of reports and output files (such as printed lists of individual students and their test scores, printed summary statistics for each class and school campus, and magnetic tape files that will be integrated into a data base for later use).

A simple model of a dp system which will perform these functions is displayed in Exhibit 1. This exhibit displays only the major stages of the model and their linkages. Each stage is named by the particular function that is executed in that stage. A detailed description of the nature of the function for each stage and of alternative ways of accomplishing this function will be described later in this paper. Several points should be noted about this model:

- The arrows indicate a probable sequence of occurrence for the functions of the different stages. More importantly, however, the arrows should be considered as indicating that the model is a single

system, containing different (but interrelated) stages.

- The editing and scoring functions are performed in each of several different stages. For example, editing functions are performed in three distinct stages, termed Edit A, Edit B, and Edit C. The exact nature of the editing function in each stage is different and each has its particular advantages and disadvantages. These differences will be discussed in later parts of this paper. It may not be necessary for an operating dp system to incorporate all three of these editing stages. Some of the criteria for deciding which stages should be included in a working dp system will also be discussed later in the paper. Similar comments also apply to the two scoring stages of the model.

- Three of the stages are represented as occurring more or less simultaneously. During the scanning stage, both the functions of the Score A stage and part of the functions of the Edit B stage are accomplished. (The box representing Edit B extends beyond the Scanning stage box. This is meant to indicate that part of the Edit B functions are performed only after the scanning has been completed.)

- Both machine and human resources are necessary to implement the model. Essential machine resources are the computer and associated peripheral equipment. Equally critical human resources would include: clerical staff, who must locate correct information for errors and enter these corrections; teachers, who may be required to do much of the marking of answer sheets for identification and control information, as well as various quality checks; and trained computer operators and programmers.

- The model is only one of many possible models. Most other models of a large-scale test processing system will perform the same four basic functions. Alternative models may differ in other ways, however. For example, additional functions may be performed; one of the stages of the model in Exhibit 1 may be eliminated or consolidated with another stage; or the sequence in which the stages occur may be changed.

External Constraints on a DP System

Most operating dp systems will differ from each other in the manner in which the function of each stage is performed, in the nature of the dependence among the different stages, and in whether certain stages are even incorporated into the dp system. These differences are in part due to the fact that there is often no unique "best way" to design a dp system. However, differences among dp systems are also in part due to the fact that there are usually external constraints that must be considered by the designer of a dp system. Designers in different agencies will probably have different types of constraints to consider.

There are essentially two categories of external constraints: resources that are available for use by the dp system and demands that are placed on the resources. As alluded to in the previous section, both the computer and people are resources. Demands will usually be formulated as objectives of the dp system. At the completion of a processing cycle, the dp system will be expected to:

(1) generate certain specified reports and certain tape files for later use;
(2) insure some specified degree of accuracy of the data on these reports and files (the accuracy objective); and,
(3) complete the reports and files by some specified date (the deadline objective).

Each of the demands listed above will require certain types and amounts of resources. There may not be adequate resources to satisfy all demands. For example, suppose that in some dp system ten days are required to perform editing work (as specified by the accuracy objective) before a report can be completed. If the deadline objective for this report stipulates completion within seven days, then this deadline objective and the accuracy objective are conflicting. Such conflicts can, to a large extent, be anticipated before a dp system is designed. The task of the designer is to create (or modify) a dp system so that such conflicts are eliminated. (In the above example, this might be possible by redesigning the dp system so that staff time could be more efficiently employed, or by transferring some of the manual tasks to a computer. However, there may be instances in which the designer must seek permission to modify the objectives to a more reasonable level.)

Editing in DP Systems for Processing Test Results: Some General Considerations

Compliance with the accuracy objective of a dp system is mostly accomplished in the editing stages. The editing stages will probably be the most complex stages of the system. There will be more alternatives to choose from in designing these stages than for any of the other stages. Three of the stages of the model displayed in Exhibit 1 perform an editing function. The greater part of the resources that are dedicated to the test processing (both computer and human) are directed toward editing activities. Clearly, in terms of both time and money, the editing function is the most costly of the four functions that are performed by the dp system.

In developing a dp system, the designer is most likely to encounter conflicts when the editing stages are being designed. The accuracy objective of the dp system will require that editing be performed, but accomplishing this task may require (apparently, if not in fact) (1) more resources than are available and/or (2) so much time to complete as to endanger compliance with the deadline objective.

For the reasons cited above, careful attention must be given to the design of the editing function of the dp system. Some general considerations in such designing are provided below.

Backup Editing. One of the advantages of the model dp system shown in Exhibit 1 is that it has three editing stages. Each stage serves as a backup for the detection of errors that passed undetected through the previous stage. With three editing stages, the chance that an error is never detected is much less than for a dp system which has only one or two editing stages.

Use of Resources. Each of the editing stages has its advantages and disadvantages in terms of (1) resource demands and (2) efficiency in the use of these resources. Careful consideration of the manner in which the available resources are distributed among the different editing stages can often resolve apparent conflicts between limited resources and the need for accuracy.

Imposing Reasonable Limitations on the Accuracy Objective of the DP System. As previously alluded to, the designer of a dp system may need to request permission to modify the accuracy objective of the dp system in order to resolve conflicts between this objective and other external constraints. Two possible ways of modifying the accuracy objective are described below. Each of these concentrates on a different aspect of accuracy--correctness or completeness.

The Criterion of "Critical Information": Correctness addresses the issue of accuracy within the individual student record on a file. For each record (containing several bits of information, such as student name and grade), the issue is the correctness of each bit of information. If the accuracy objective stipulates that each bit must be checked for correctness, then considerable editing resources will be required to accomplish this task. The concept of "critical information" may be employed to assist in determining how the accuracy objective of the dp system might be modified so that

the demands for correctness within the individual student record can be reduced. The basic idea is simply not to waste time in correcting information that will provide little payoff. More specifically:

- For each student, there is available a set of information about that student and the testing situation (including, for example, the student's name, grade, and sex; the school and classroom attended by that student; and the test level and form administered to the student). The "critical information" for each student is defined as the subset of this information which satisfies both of the following requirements:

  (1) the correctness of the information is essential, and
  (2) the dp system is the only practical method of assuring that if the information is incorrect, this error can be detected and corrected.

- The accuracy objective is then reformulated to stipulate that only "critical information" will be edited and all available editing resources are concentrated on this "critical information."

Some examples will illustrate the use of this concept.

(1) If reports are to be created using percentile rank scores, then the student grade should be considered as "critical information." (The student grade is necessary in order to determine the correct percentile score. If the wrong grade is used, this error would very likely never be detected later.)
(2) The spelling of student names would probably not be considered as "critical information." (The information might be essential, but errors could easily be detected and corrected by classroom teachers.)
(3) Student sex might not be considered as essential if sex data was only used in districtwide summaries. (In such summaries, a few errors would not seriously affect the summary, so sex information would not be essential.)

The Criterion of "Complete-Enough": Completeness addresses the issue of accuracy for an entire file of records. For this file, the issue is whether all of the student records that should be in the file are in fact in the file. If the accuracy objective stipulates that a report cannot be generated until the input file for the report is "complete", then conflicts with the deadline objective of the dp system may occur.

The concept of "complete-enough" may be employed to assist in determining how the accuracy objective of the dp system might be modified so that this type of conflict can be minimized. The basic idea is simply that a report based on the testing results of, say, 98% of the students (and delivered on time) may in some instances be better than a report based on all students but delivered one day late. More specifically:

- For a given report which will be based on records in a file named, for example, the Master Test Results (MTR) file, it is decided what number or percentage of records must be contained in the file before the report can be generated.

This decision is a judgmental one, based on knowledge of the purpose of the report. Statistical summaries might be based, for example, on 95% of the students. On the other hand, however, for listings of individual students and their scores, a "complete-enough" file might be defined as a file with "at least 99%" records present.

- A record is added to the MTR file for each answer sheet that is scanned and passes through the entire dp system without any errors being detected. Records which do have errors are also added, but only after they have been corrected. Each time additional records are added to the MTR file, the total number of records now on the file is counted to determine if the MTR file is "complete-enough" for that particular report.

- If the deadline for the report is near and the MTR file is "complete-enough," then that report is generated.

- If necessary, the report can be regenerated after all records have been added to the file.

Edit A: The First Stage of the Model

Edit A is the first of three editing stages in the model. Edit A is essentially a manual review (and correction, if necessary) of the answer sheet information before the scanning is done. It is generally accomplished by local school campus personnel (teachers, clerical staff, and possibly students). Some errors will inevitably remain undetected after this editing has been concluded; others may have been inadvertently created. For this reason, it may be considered advisable to include one or both of the other editing stages in the dp system as well as this editing stage. (Whether or not additional editing at later stages is necessary will be in part determined by the accuracy objective of the dp system. If the accuracy objective stipulates an extremely high assurance that errors have been detected and corrected, and the specific editing procedures in Edit A do not provide that assurance, then additional editing in later stages will be necessary.) The detection of errors in Edit B and in Edit C is done by computer and is very thorough and efficient. However, the correction of errors that are detected in these later editing stages must be done manually by the testing office clerical staff, which probably has only limited manhours available for such corrections. It is therefore advisable to accomplish as much editing as is possible at the local school campus level (during this Edit A stage) so that the manual parts of the editing can be distributed among as many people as possible.

Two different designs for accomplishing Edit A are presented in this paper: Edit A1 and Edit A2. The essential difference between the two designs is that A1 is completely manual, while in design A2, much of the work is accomplished by a computer and a line printer. The remaining work (which must still be performed manually) can thus be more easily accomplished. The principal consequences of using design A2 are therefore (1) greater accuracy and (2) reduced time requirements by local school staff.

A flowchart of each of the pre-scanning editing designs is displayed in Exhibit 2. The main steps in these designs are labeled for easy reference. Step A1(a) is the first labeled step for design A1, step A2(a) is the first labeled step for design A2, and so on. These two designs are discussed in detail below.

Pre-scanning Editing: Design Alternative A1. This design is completely manual. Except for the last step it is accomplished entirely at the local campus level. The essential steps of this design are listed below.

A1(a) - The appropriate bubbles for all identifying information are marked. This would include, for example, student name and grade, identifying school and class numbers, and level of test used. Some of this information may be bubbled onto separate header answer sheets--one header sheet for each class, for example. The marking is done by teachers, school clerical personnel, students, and others. Strictly speaking, this is not an editing function. However, for convenience in this discussion, this step is included in design alternative A1.

A1(b) - All of the "critical information" that was bubbled in the previous step is edited for accuracy and completeness. This editing may be done more or less simultaneously with the previous step. However, if students are asked to perform some of the bubbling (during the first few minutes of the test administration period), then some editing of their markings may be necessary after the testing.

This step can be very time consuming, especially if each bubbled mark for which accuracy is important must be individually examined to insure that the mark is properly placed and that there are no stray marks.

A1(c) - After all testing has been completed, some additional editing should be considered:

- inspection of test item responses for smears, double bubbling, etc.
- inspection of answer sheets for tears or other damage that might cause the optical scanner equipment to jam.
- batching the answer sheets--insuring that all sheets are right-side-up and, if applicable, grouping of answer sheets by class or school and/or insertion of header sheets.

This last step may be performed at the local campus level and (for the last two types of editing listed above) again at the district office.

Pre-scanning Editing: Design Alternative A2. This design alternative performs the same tasks as would be accomplished in A1 but here much of the work is computerized. The remaining manual work that must be performed by school campus personnel is less time consuming and may be accomplished with greater accuracy. The design requires the use of a computer-readable file of the student and other data that must be marked on the answer sheets. (This file is called the Master Student Information file, or MSI file). Also, the design requires more manhours at the district testing office than does design alternative A1. The five essential steps of this design are listed below.

A2(a) - Printout lists of the MSI information are prepared.

A2(b) - The printout listings are distributed to the local school campuses for editing. If the printout listings are well designed and the instructions provided to schools are clear, this editing may be easily accomplished by lining out incorrect information and printing the correct information in spaces provided on the listing.

Some key advantages of design alternative A2 result from this type of editing.

- The editing is based on reading printed information, rather than on inspection of the proper location of each individual bubble marking. Errors in printed material

can be spotted more quickly, and fewer errors are liable to escape detection.

. The editing is completed before the tests are administered. Scarce after-testing time is not consumed by this editing and the possibility of not meeting deadlines is reduced.

A2(c) - The edited printouts (annotated with changes, additions, and deletions) are returned to the district testing office. The changes, additions, and deletions are then entered into the MSI file.

It was mentioned earlier that design alternative A2 required more central office personnel time than does alternative A1. The increased time is necessary at this step. The amending of the computer file may be accomplished by keyboard entry directly into the file, by keypunching cards to be read by a correcting program, or by preparing special scannable documents with corrective information. Whichever method is used, clerical staff is needed to perform these tasks.

A2(d) - After the MSI file has been completely updated, the answer sheets are preslugged; that is, for each student, an answer sheet is prepared with all identification bubbles marked by a line printer. The preslugged answer sheets are then distributed to the schools. No more bubbling is necessary (other than student marking of responses to test items). No editing of the bubbled identification information is required since all necessary editing of this information has already been completed before the bubbles were preslugged.

A2(e) - This final "wrap-up" editing is done just as would be done in design alternative A1.

It should be noted that even though design A2 is used with the preslugged answer sheets, it will inevitably occur that some students will have to use manually prepared answer sheets and additional editing of all answer sheets will be beneficial. This is because (1) some new students may enroll in the school after the A2 editing and will need to have manually prepared answer sheets, and (2) there will be some undetected errors on the preslugged answer sheets that will be found later, during the testing; these preslugged answer sheets will be discarded for manually prepared ones which presumably are correct in all regards.

Strengths and Weaknesses. The relative strengths and weaknesses of these two designs are described below.

Accuracy: Design alternative A2 is the more effective editing procedure. More errors are likely to be detected since the editing consists of examining printed information rather than inspecting each bubble marking for proper location. Also, since bubbles are marked by computer, there will be no errors due to careless marking of the bubbles.

Deadlines: All of the more time-consuming tasks of alternative A2 are completed before the test is administered. Therefore, design A2 cannot create more of a deadline problem than would design A1. However, depending on how design A1 is implemented, some of the editing in step A1(b) may have to be performed after the test has been administered. In this event, if unexpected delays in completion of this editing occur, then there will be increased difficulty in finishing the processing cycle before the required completion date.

Computer and Computer-related Requirements: There are no requirements of this type for design alternative A1. Alternative design A2, however, requires (1) computer facilities, including a line printer (although no more than will be necessay anyway at later stages in the dp system), and (2) a master file of student and other information in a computer-readable form (the MSI file).

Personnel Time and Skills: Both designs require campus level personnel time. Design alternative A2 will require much less school campus time but will require more clerical time at the district testing office. Design A2 requires that personnel time be available before the test administration (typically, three to four weeks prior to testing). This may cause problems for an early fall testing program.

Scanning: The Second Stage of Test Processing

The purpose of the scanning stage is to transfer the bubbled answer sheet information to a computer-readable medium such as tape. Specific details of this scanning process will not be discussed, with two exceptions.

The sequence in which the answer sheets are arranged before scanning may be an important consideration. For example, Baker (1971) suggests that answer sheets be grouped hierarchically by class, grade, school, etc. before the scanning is done. This sequencing can facilitate the generation of certain reports during the last stage of the dp system. (This will be discussed later in the paper.) There is one drawback to such a method which should be considered. Inevitably, some answer sheets will not be turned in to the testing office with the others and will be "found" only after the scanning has been completed. Procedures will therefore be required to scan these sheets as a separate batch and to insert records for these answer sheets into the tape files at the proper location. If such procedures are available, then this raises the question of whether the actions to insure that the answer sheets are properly sequenced before the scanning are worth the additional effort.

With certain types of optical scanner equipment, parts of the scoring and editing functions may be performed by the scanner. These are the functions accomplished in the Score A and Edit B stages. These two stages are discussed in the following sections.

Score A: Scoring During the Scanning

Some optical scanners have a small computer associated with them which has the capability of right-wrong scoring of each item response and of computing raw scores for each test and subtest. Both of these tasks may be performed by the mainframe computer during the Score B stage of the processing cycle. However, the use of Score A is preferable under certain conditions. Once raw scores are computed, the item response data may not be of further interest. If this is the case, then the scanner output tape need not contain this quite large amount of information. This shorter file will be more quickly processed through the remaining stages of the dp system.

Edit B: Editing During the Scanning

In the earlier discussion of the Edit A stage, it was indicated that some errors may pass undetected through that stage. During the Edit B stage, the optical scanner can very efficiently detect certain types of errors that had escaped earlier detection. These are the types of errors in which (1) a bubble in an answer sheet column should have been marked but was left blank, and (2) two or more bubbles were marked in the same answer sheet column.

The editing function in this stage cannot detect any other type of error, such as on an answer sheet for a fourth grade student for which the fifth grade bubble has been marked. If more editing of this type is needed, then the Edit C stage must be incorporated into the dp system.

Three different design alternatives--B1, B2, and B3--are discussed as possible approaches to accomplishing the editing work in the Edit B stage. Exhibits 3, 4, and 5 display these different designs. The designs are described below.

Edit B: Design Alternative B1. This design has been suggested by Baker (1971). The principal advantage of this design is that the sequence of records on the tape file remains--after all editing has been completed--exactly the same as the sequence of answer sheets before the scanning. (As mentioned earlier, this may be advantageous during the last stage of the dp system.) The four specific steps of this design are listed below.

B1(a) - Each answer sheet is scanned and checked for errors. After scanning, the sheet is placed by the scanner into one of two stacks--an "error" stack (containing all answer sheets for which one or more errors have been detected) and the other stack (containing all errorless answer sheets). For each answer sheet, a record is copied onto the Master Testing Results File (MTR). If that answer sheet contains errors, then the record is also copied onto an exceptions file.

B1(b) - Answer sheets in the "error" stack are examined to determine what corrections are needed. In some instances, the correct information cannot be ascertained from the answer sheets, and other sources (such as independently compiled lists of student data or telephone calls to the appropriate school campus) may be necessary.

B1(c) - Records in the exceptions file are corrected.

B1(d) - The exceptions file and the MTR file are merged, creating an output MTR file with all errors corrected. This combined file now enters the next stage of the dp system.

Edit B: Design Alternative B2. One of the disadvantages of design B1 as described above is that none of the later stages of the dp system can be implemented for a batch of records until all of the records have completed the editing in Edit B. Design alternative B2 is one method of circumventing this type of delay. B2 allows errorless records to proceed immediately

to the next stage of the dp system. Only those records with errors are retained in the Edit P stage until the corrections have been completed. If the accuracy objective of the dp system allows the use of "complete-enough" files for the creation of reports (see the earlier section of this paper on general considerations for editing), then design B2 will reduce the possibility of not meeting deadlines. The steps of B2 are listed below.

B2(a) - This step is identical to the first step of design B1, with one exception: the MTR file which is created by this step will contain only records with no errors. This MTR file then proceeds immediately to the next stage of the dp system.

B2(b) - This step is identical to step B1(b) of design B1.

B2(c) - This step is identical to step B1(c) of design B1. After this step is complete, the output file proceeds immediately to the next stage of the dp system.

Edit B: Design Alternative B3. This design is a simplified version of design B2. The steps of this design are as follows.

B3(a) - As in the first step of the other two designs, the answer sheets (after scanning and editing) are placed by the scanner into one of two stacks. However, only one output file--the MTR file--is created and only errorless records are copied onto this file.

B3(b) - The answer sheets with errors are inspected. Answer sheets for which the correct information can be immediately determined are corrected, re-scanned, and entered onto the MTR file with the other records. After this step, the MTR file proceeds immediately to the next stage for continued processing.

B3(c) - For the remaining answer sheets with errors, other sources are consulted for the correct information.

B3(d) - Correct information is entered on the answer sheets, which are scanned and entered onto an MTR file (different from the file used in steps B3(a) and B3(b)). This MTR file then proceeds immediately to the next stage for continued processing.

Strengths and Weaknesses. The strengths and weaknesses of each of these three designs are described below.

Accuracy: Design B3 has a slight advantage over the other two designs in correcting errors. All of the designs detect errors equally well, but only B3 has a built-in mechanism for checking each "correction" to insure that it is proper.

Deadlines: Designs B2 and B3 both allow all errorless records to pass quickly through the stage and on to the other stages; these errorless records need not be held up for a few records in the same batch which need correcting. Because of this feature, designs B2 and B3 permit the use of the "complete-enough" file concept which may prevent the breaking of deadlines. Design B3 has a slight additional advantage: the design provides for immediate correction and rescanning of as many answer sheets as is possible, reducing even more the number of records that must be held up while the correcting process is occuring.

Computers and Computer-Related Requirements: Design B3 is the least demanding design, requiring only a scanner. The other two designs both require standard computation center facilities.

Personnel Time and Skills: The amount of clerical time that is required is about the same for each of the three designs. However, designs B1 and B2 also require specialized training in keyboard entry or in keypunching skills.

Edit C: The Last Edit Stage

By the time that the student test records arrive at this stage, many but not all of the errors have been detected and corrected. In Edit A, the "critical information" was manually examined and any detected errors were corrected. Because of limitations to the procedure and because of the inevitable human mistakes, some errors passed undetected through this stage. Certain types of these undetected errors (those caused by unmarked bubbles or by double bubbles on the answer sheets) were easily caught during the Edit B stage and corrected. The remaining types of errors (such as the error caused by a fourth grade student who marks the fifth grade bubble on his answer sheet) could not be detected during the Edit B stage and must now be dealt with in Edit C.

Edit C requires the use of a computer-readable file of student information, the Master Student Identification File (MSI). This file contains all of the "critical information" about the students. It is assumed that this information is correct and that if this information is not identical with the testing results information for a particular student, then the testing results information is suspect and is examined for errors.

If design A2 is used in the Edit A stage, then the MSI file used in Edit C should be a more recently updated version of the MSI file used in Edit A. (Otherwise, the Edit C procedure will do nothing more than separate out the records for students who did not use preslugged answer sheets. This could be more efficiently accomplished in other ways which would not even require the use of the MSI file.)

However, Edit C can serve a significant editing function even if A2 is also used--if the MSI file is updated as of the test administration day(s), and this updated version of the MSI file is used in Edit C. This updating would include (1) adding information for new student enrollees who were not in attendence during the A2 editing, and (2) changing information representing errors that were uncorrected during the A2 editing.

Two alternative designs for this stage--C1 and C2--will be considered. Exhibits 6 and 7 display these designs.

Design Alternative C1. This design is similar to design B1 of the Edit B stage in two regards: (1) the sequence of student records remains as the sequence of answer sheets during the scanning and is undisturbed by the editing, and (2) potential conflicts with deadline objectives may be created because the concept of "complete-enough" files cannot be used. The four steps of this design are described below.

C1(a) - All input MTR records are copied onto the output MTR file and are also matched with records on the MSI file, for each bit of "critical information." MTR records which do not pass this matching test are also copied onto an exceptions file. A printout listing of all records on this exceptions file is created.

C1(b) - The printout listing and other appropriate sources (such as independently compiled lists or conversations with the staff of the appropriate school campus) are examined to determine what the correct information should be.

Two points should be emphasized here:

. The printout will not in general reveal which bit or bits of information for a student are incorrect. Creative "detective work" will often be necessary to determine what needs correcting.

. Theoretically, the Edit B stage might be eliminated, with all errors that might be detected in that stage being detected in Edit C, instead. There are two reasons why this would not be an efficient procedure: (1) As mentioned above, Edit C cannot indicate which bit of the information for a particular student is incorrect--it can only indicate that something is wrong for that student. However, the Edit B procedure can provide this additional information. (2) In Edit B, the answer sheets for all records that have errors are conveniently grouped together by the scanner. Such a convenient grouping is not done in Edit C, and additional people resources are necessary to locate the necessary information sources.

C1(c) - Records in the exceptions file are corrected.

C1(d) - The exceptions file and the MTR file are merged, creating an output MTR file with all errors being eliminated. The next stage of the dp system is now entered.

Design Alternative C2. This design is identical to design C1 except: (1) the MTR file that is created in step C2(a) contains only records which have no detected errors, and this file passes immediately to the next stage; and (2) the exceptions file that is created in step C2(c)--with all errors now corrected--passes immediately to the next stage.

Strengths and Weaknesses. The relative strengths and weaknesses of these two designs are described below.

Accuracy: Both designs are equally capable of detecting errors. The quality of error detection is dependent, however, on the quality of the Master Student Information (MSI) file. If design A2 is used in the Edit A stage and the MSI file is not updated after this editing, then Edit C does not provide an efficient error detection procedure.

Deadlines: Design C2 allows all records that have no errors to pass quickly through this stage and on to the last stages; these errorless records need not be held up for a few records in the same batch which require correcting. Because of this feature, design C2 permits the use of the "complete-enough" file concept which may prevent breaking deadlines. Design C1 cannot use the "complete-enough" file concept, and therefore

may result in not meeting a deadline.

Computers and Computer-Related Equipment: Both designs are comparable in this regard. They both require a reasonably sophisticated computation center.

Personnel Time and Skills: Both designs are comparable in this regard. Not too much staff time will be necessary if the editing in the previous stages has successfully detected most of the errors. However, the type of clerical task that is necessary in this stage can consume a considerable amount of time if there are too many errors that require correcting.

Score B: The Final Scoring Stage

During this stage, derived scores (grade equivalent scores, percentile rank scores, etc.) corresponding to each raw score are determined and added to the test results record for each student. If the Score A stage is not incorporated into the dp system, then the right-wrong scoring of each test item and the computation of raw scores for each test and subtest will also be accomplished during this stage, before the derived scores are determined.

It should be noted that this stage follows the editing stages for a specific reason. The derived scores can only be determined after other information is known. For example, the grade equivalent score for a given raw score depends also on which test level and form were used, and the percentile rank score depends in addition on the grade of the student and the period of year during which testing occurred. Some of this other information may be obtained from the student test records and may be inaccurate. It is therefore advisable to have completed the editing of such information before the derived scores are determined.

Creation of Reports and Output Files: The Last Stage

After the functions in the Score B stage are completed for the student test records in a file, the file is passed to the control of the last stage of the dp system. During this last stage one or more of three activities will occur.

(1) The file will be merged with another file which is accumulating all student test records (or, perhaps, all of the records for one particular test level, with other accumulating files serving to collect student test records for other levels of the test). It is this type of accumulating file which may be utilized when employing the concept of "complete-enough" files.

(2) This file (or the accumulating file) will serve as the basis for generating several reports. Some of these reports will require a prior sorting in order to provide, for example, a rank-ordering of student names in accordance with their test scores, or an alphabetic listing of students with their test scores, or summary statistics by classroom and by school. As noted by Baker (1971), this last type of report can be generated easily and without sorting of the file, if the answer sheets were grouped by class within school before scanning and if this sequencing was undisturbed by the processing.

(3) The file is integrated into an existing data base for other purposes such as longitudinal tracking of students.

Reference:

Baker, Frank B. Automation of test scoring, reporting, and analysis. In Robert L. Thorndike (Ed.), Educational Measurement (2nd ed.). Washington, D.C.: American Council on Education, 1971.

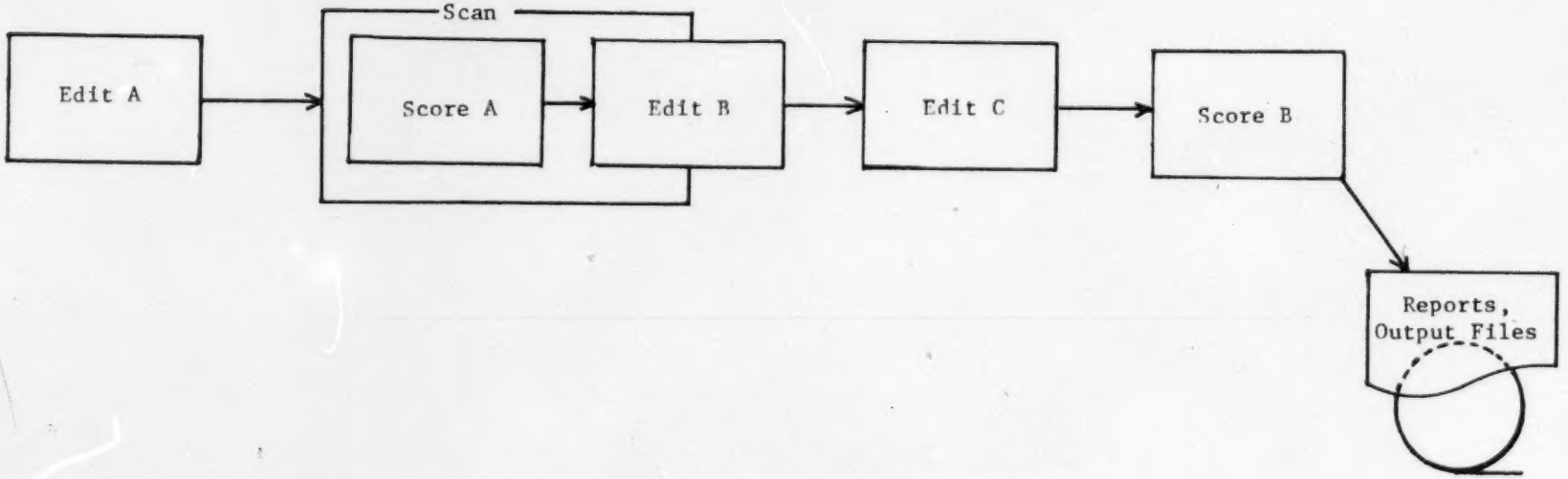

Exhibit 1. A Model of a Data Processing System for Testing

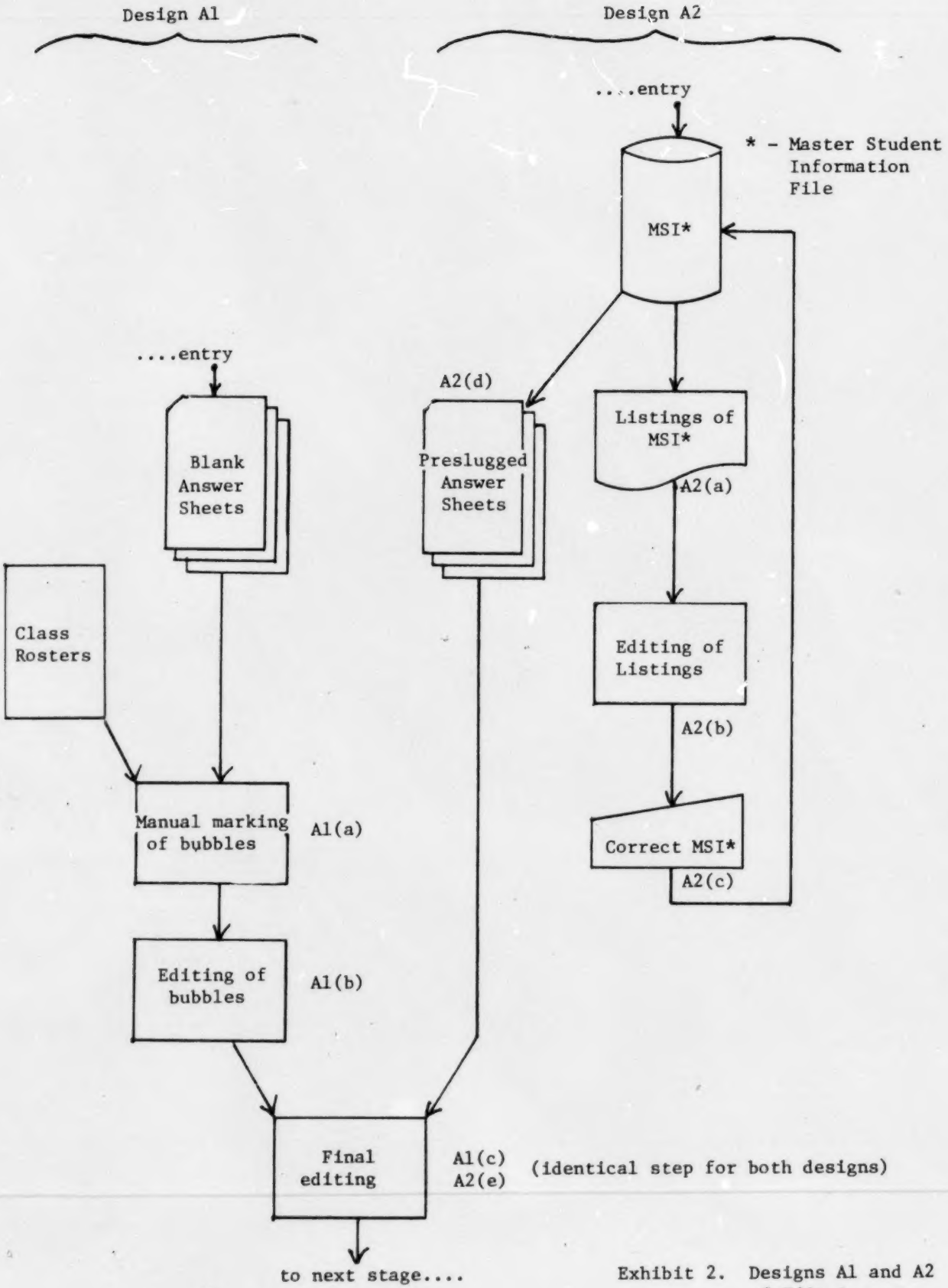

Exhibit 2. Designs A1 and A2 of Edit A

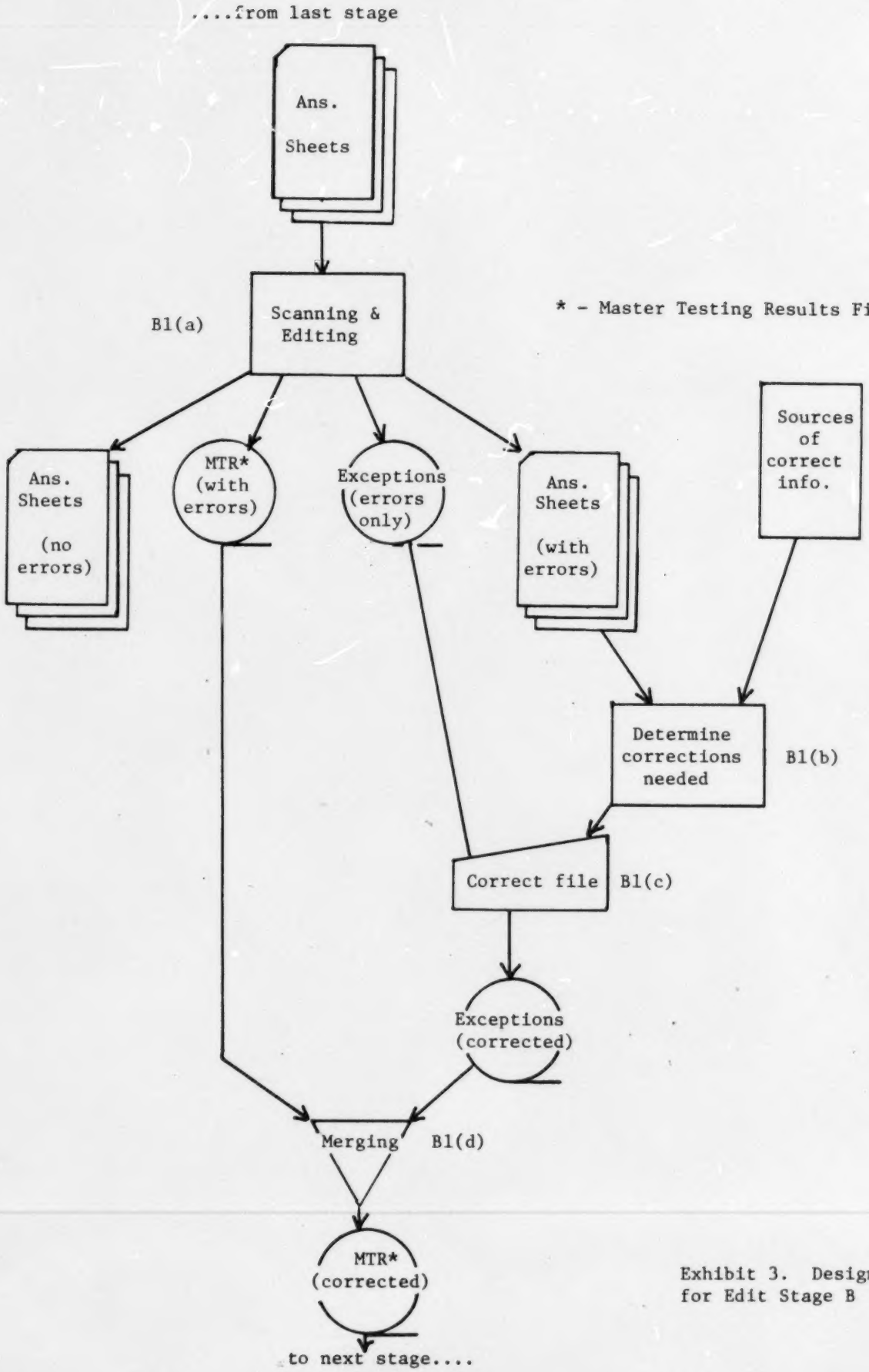

Exhibit 3. Design B1 for Edit Stage B

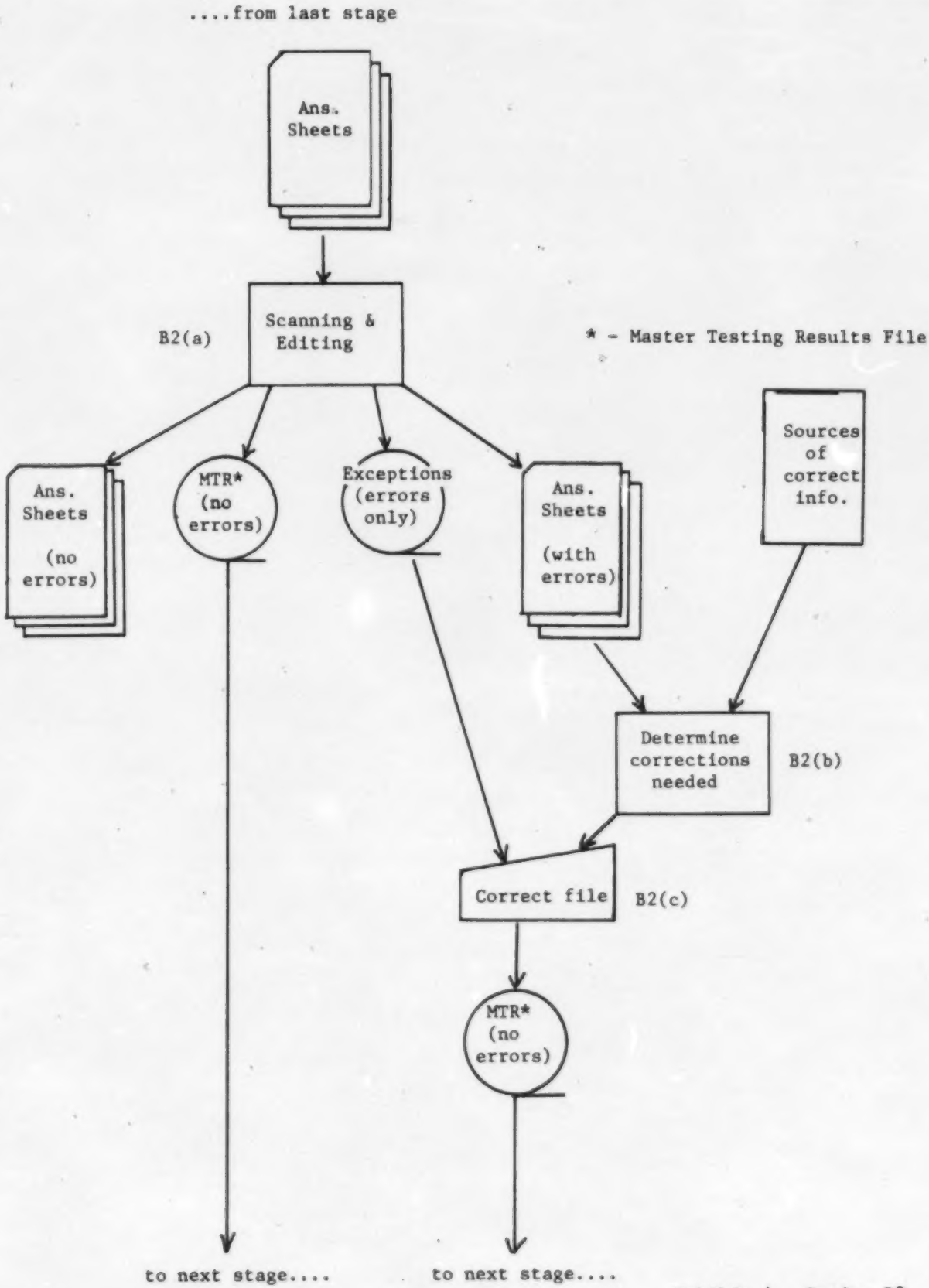

Exhibit 4. Design B2 of Edit Stage B

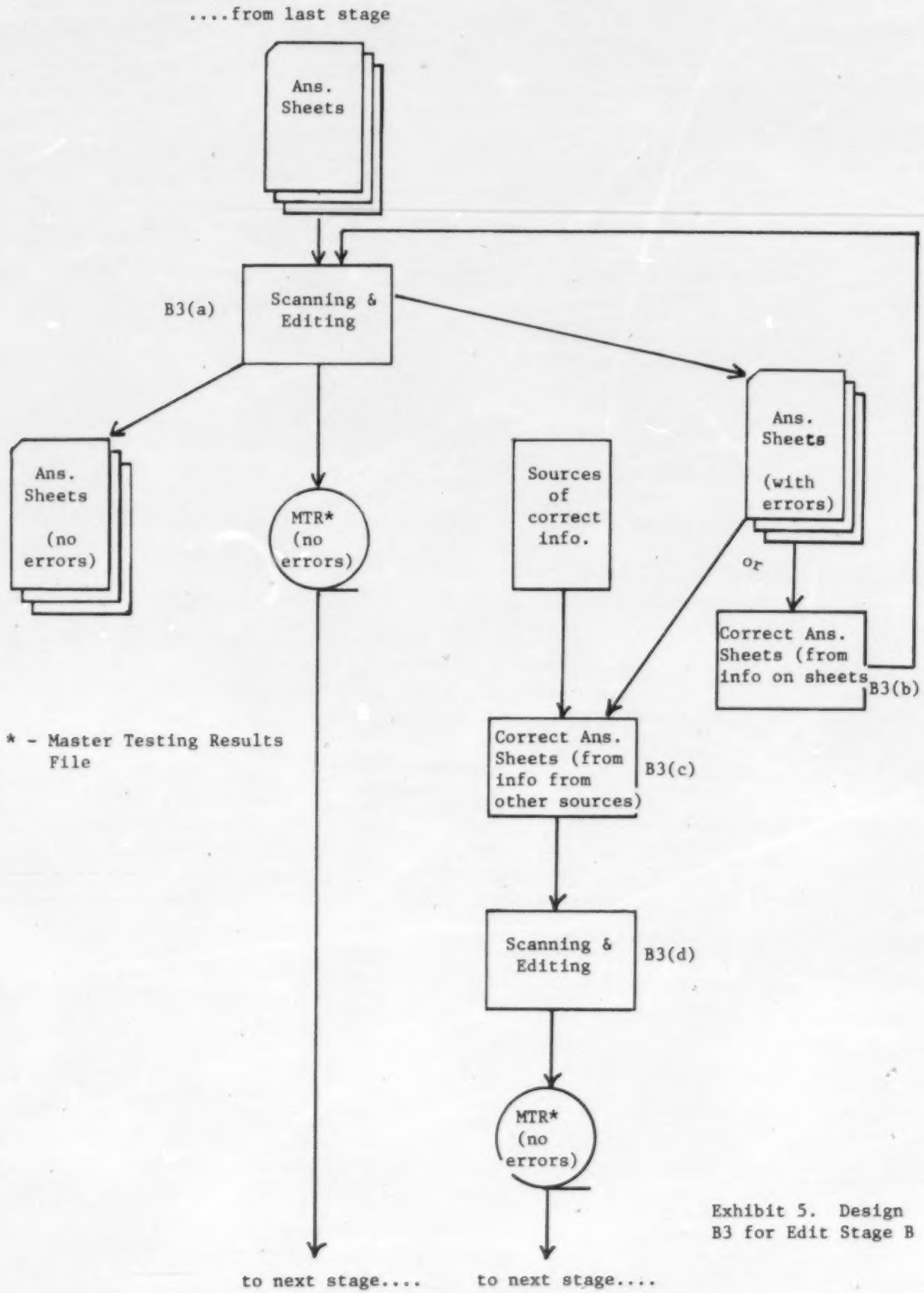

Exhibit 5. Design B3 for Edit Stage B

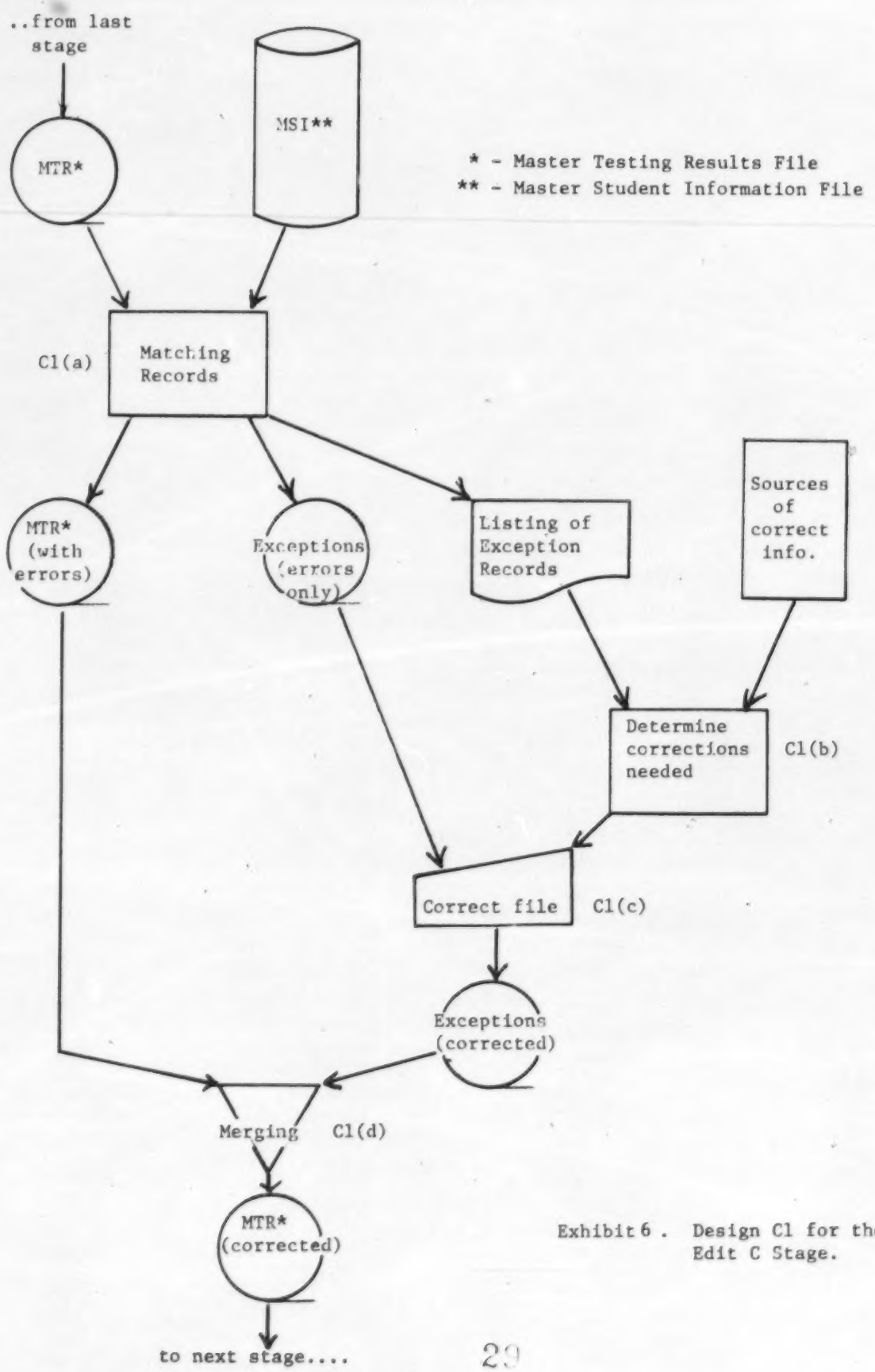

Exhibit 6 . Design C1 for the Edit C Stage.

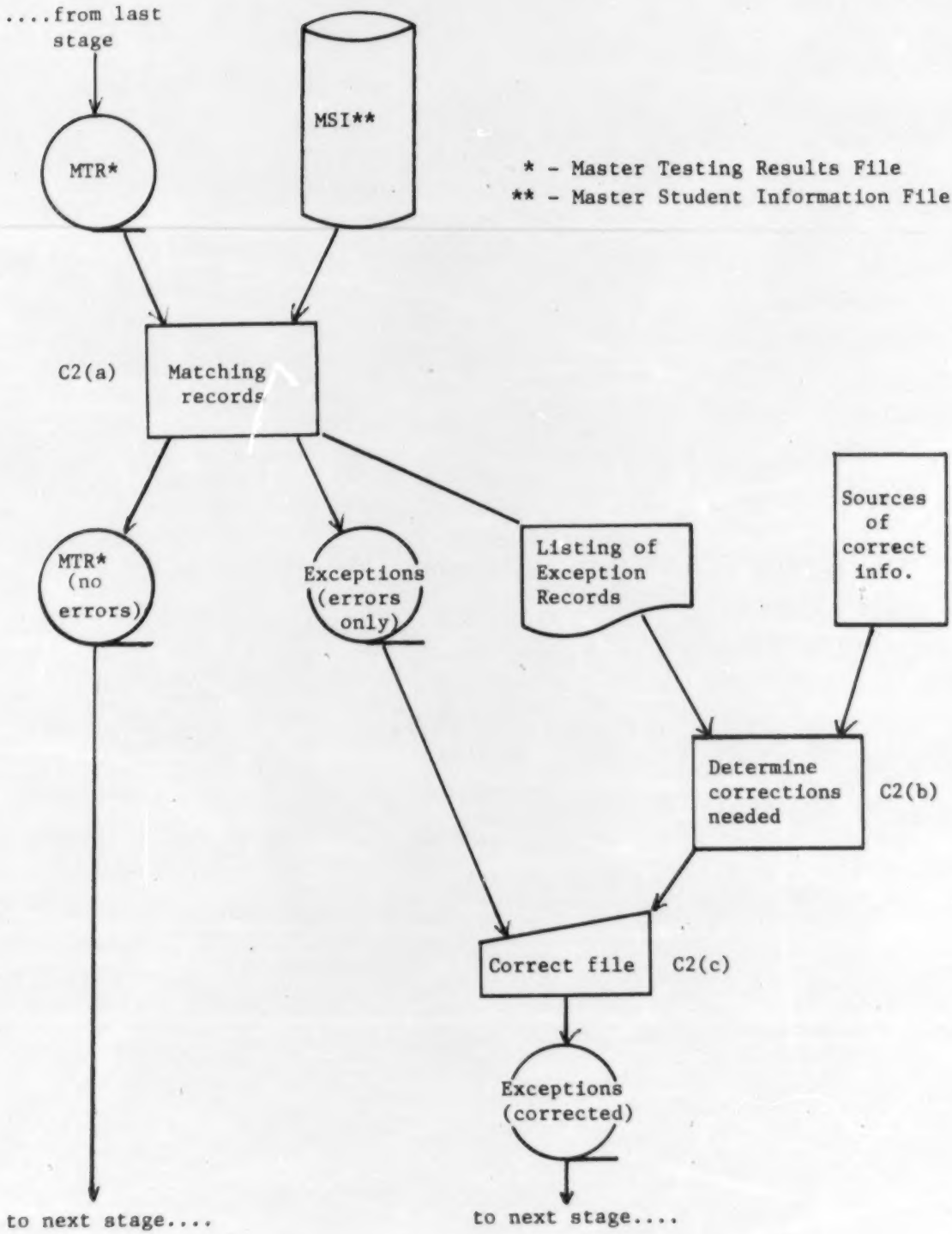

Exhibit 7. Design C2 of the Edit C Stage